Hawaiian Electric
Maui Electric
Hawai‘i Electric Light

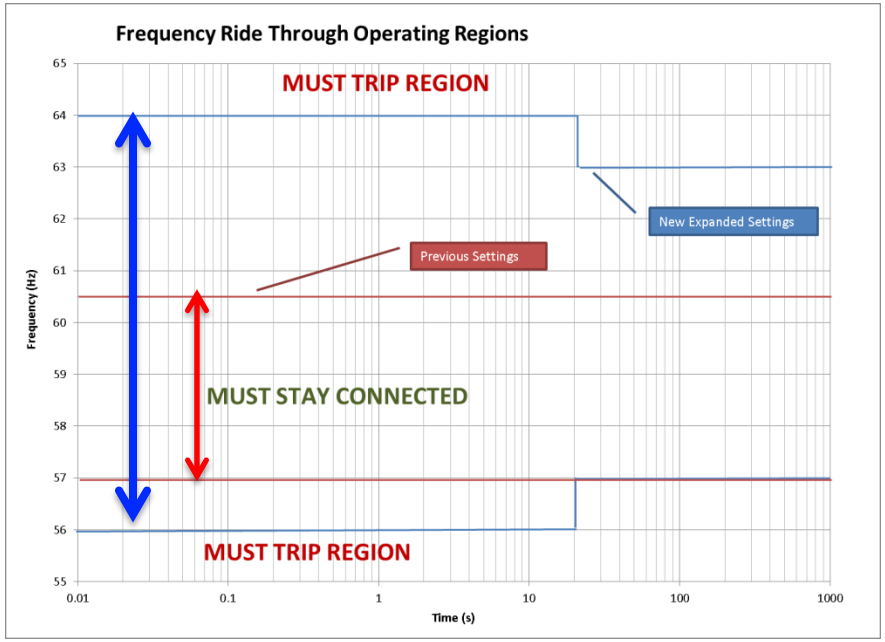
New Requirements for Advanced Inverters in Hawaii

Friday, October 23, 2015

Ken Fong, P.E.
Manager, Transmission & Distribution Planning
Hawaiian Electric Company

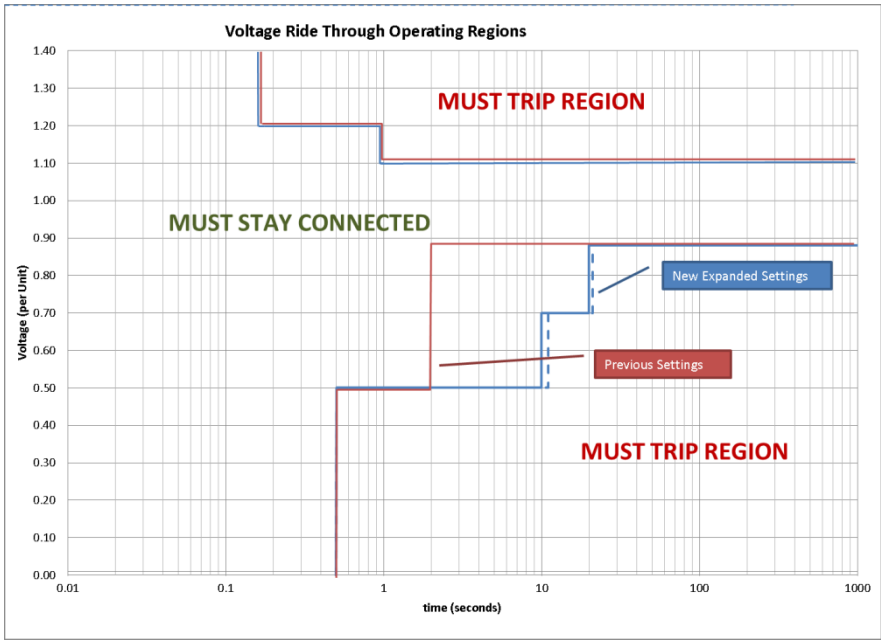
Ride-through standards were established to assist during system disturbances

Low/High Frequency Ride-Through



Inverter will ride-through system contingencies (i.e. loss of large load or generating unit)

Low/High Voltage Ride-Through

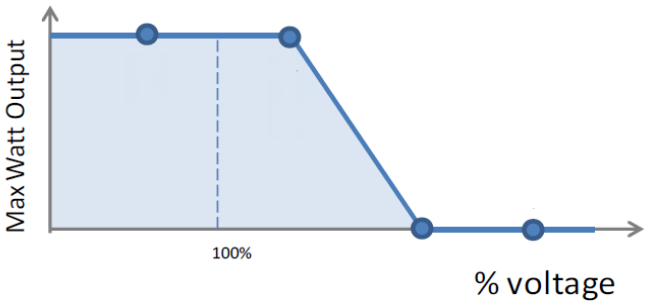


Inverter will ride-through system or circuit disturbances (i.e. short circuit faults)

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

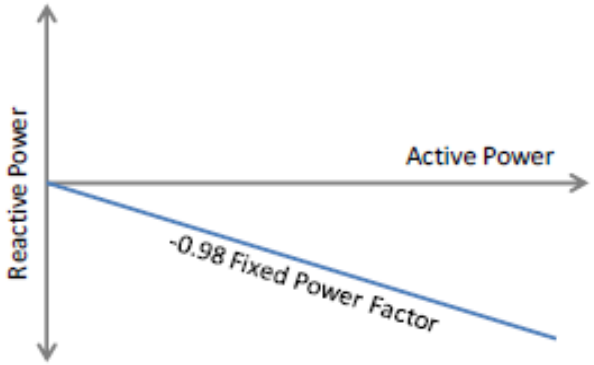
Adoption of autonomous advanced inverter voltage functions may mitigate voltage issues

Volt-Watt



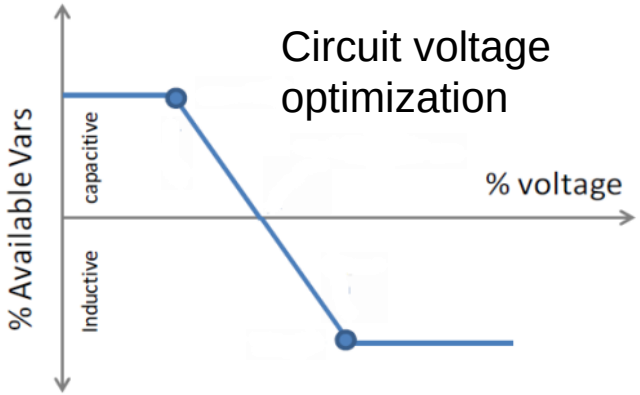
Mitigates secondary high voltage by reducing real power as a function of voltage.

Fixed Power Factor



Provides voltage support; mitigate high voltages. May increase system losses.

Dynamic Volt-Var

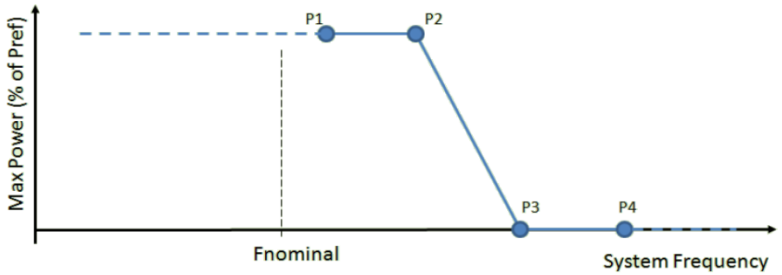


Circuit voltage optimization

Source: EPRI Report 3002001246

Advanced inverters may provide system support

Frequency-Watt



May assist in over-frequency due to of loss of load/excess energy

Soft-Start

Gradually raises the inverter power output to coordinate with the ramping capabilities of the bulk generating system. Mitigates frequency swings during system restoration.

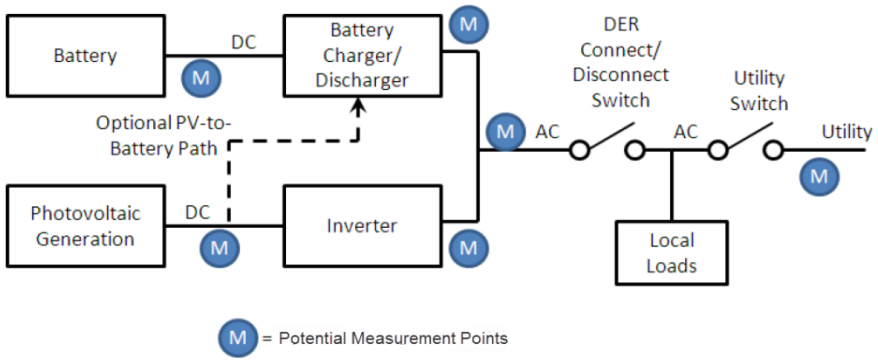
Remote Connect/Disconnect

Utility sends command to inverter to disconnect or reconnect system. To be used during system emergencies or system restoration.

Communications

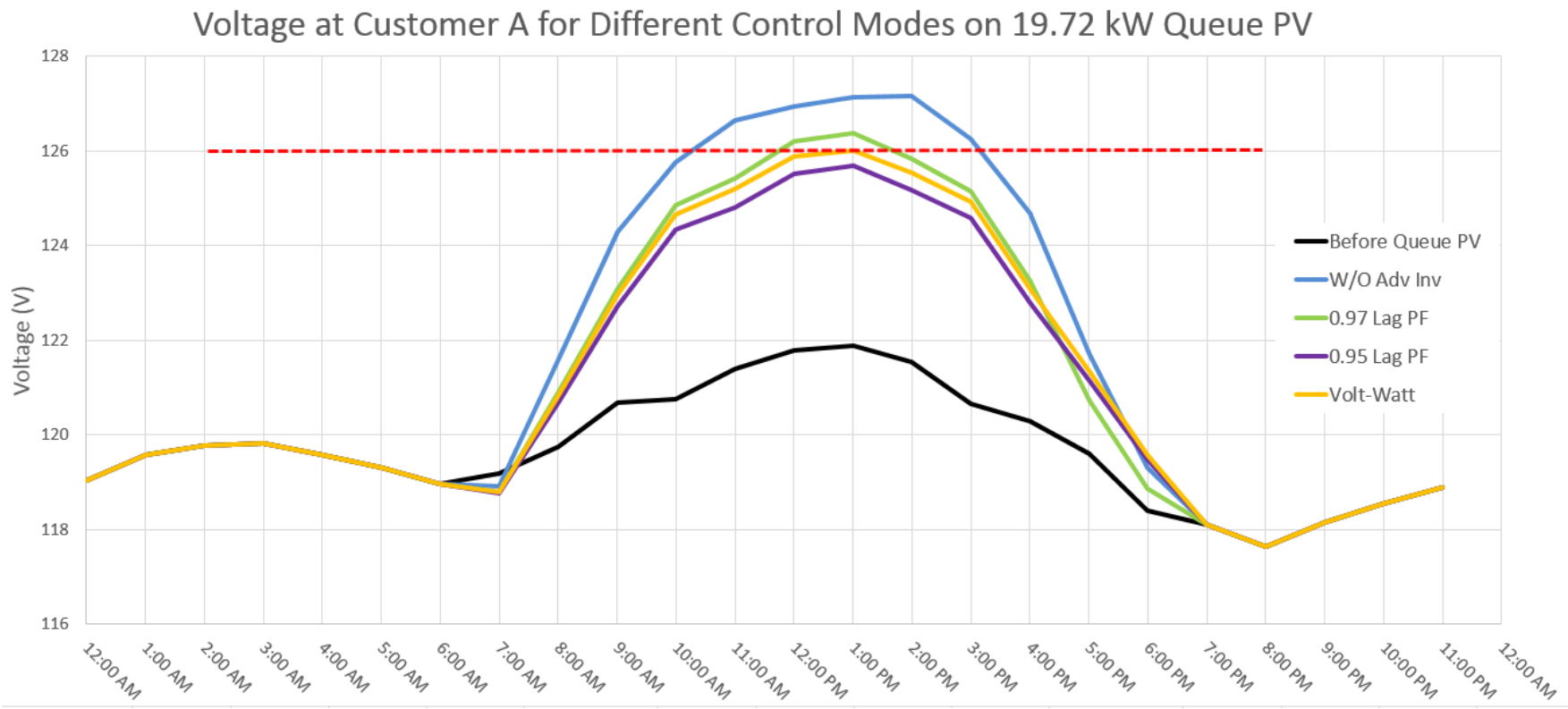
Remote Configurability

Measurement/Visibility



Source: EPRI Report 3002001246

Fixed power factor can mitigate localized high voltage and reduce voltage fluctuations



Nation leading adoption schedule for advanced inverter technical standards

Required: All applications received after January 1, 2016 must comply with dates or updated to comply after UL Cert

Advanced Inverter Functions	Hawaiian Electric Priority	Effective Date of Implementation
Anti-Islanding TrOV-2	Mandated – High Implemented	February 9, 2015
Low High Volt Ride-Through	Mandated – High Implemented	Full Settings October 1, 2015
Low-High Frequency Ride-Through	Mandated – High Implemented	Full Settings October 1, 2015
Volt-Var Control	Mandated – Low	12 Months after UL 1741 Supplement A is Approved by UL
Ramping	Mandated – Low	12 Months after UL 1741 Supplement A is Approved by UL
Fixed Power Factor	Mandated – High	January 1, 2016
Soft-Start Reconnection	Mandated – High	12 Months after UL 1741 Supplement A is Approved by UL
Frequency-Watt	Mandated – High	12 Months after UL 1741 Supplement A is Approved by UL
Voltage-Watt	Mandated – High	12 Months after UL 1741 Supplement A is Approved by UL
Remote Reconnect/Disconnect	Mandated – High	No UL Certification Required
Remote Configurability	Mandated – High	12 Months after UL 1741 Supplement A is Approved by UL

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

The Hawaii Public Utilities Commission recognized the urgent need for accelerated adoption of advanced inverters

The Hawaii PUC recently ruled on Hawaiian Electric's proposed advanced inverter implementation plan:

- **To ensure safety and reliability in our high PV penetration environment, the Companies may propose to accelerate the activation of other advanced inverter functions prior to the implementation of UL-1741 test standards.**
- **The Companies shall collaborate with inverter manufacturers to develop a reasonable self-certification process for advanced inverters until national standards (UL-1741) are established.**
- **Phase 2 of the proceeding to focus on communication standards to enable the remote connect/disconnection and inverter configurability functions**
  - Commission recognized that these functions are desirable